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December 10, 2004

Dorothy Shimer
Research Division
Air Resources Board
PO Box 2815
Sacramento, CA 95812

Dear Dorothy,

I have read with great interest the draft report to the California Legislature entitled Indoor Air Pollution in California. Although I am outsider living in Arizona, I feel that some of the research we have done and reported to Peggy Jenkins, Manager of your Research Division, is very relevant to indoor air quality problems in California.

Your report has outlined numerous steps that can be taken to minimize sources of indoor contaminants. However, I believe that in addition to minimizing source emissions, we also need a vehicle to identify the population that is currently at risk but don't know it and provide proper education and information for them. California has demonstrated leadership in the area of schools and protecting school children. This is great! Another age group which I am very concerned about is the senior group, many of whom have no clue that some of their ailments are caused by poor indoor air quality. There needs to be some attention paid to ensuring that this age group is educated and informed. Briefly, I will share in this letter what our company is planning on doing next year to start this education process in Arizona.

Our research during the past three years has focused on indoor air quality in residential houses and specifically on the contribution of insulation materials used inside HVAC systems to poor air quality. The results of our research have showed that during the summer months significant formaldehyde and other organic vapors are generated by insulation materials (duct liner) used inside the HVAC air handling system. These results are given in the following reports we have written. HVAC System Off-Gassing at Elevated Temperatures in Residential Houses Part I, April 2003, HVAC System Off-Gassing at Elevated Temperatures in Residential Houses Part II, June 2004, HVAC System Off-Gassing at Elevated Temperatures in Residential Houses, Case Studies 002-005, September 2004.

The injection of formaldehyde and other organic vapors into a residence via the HVAC air ducts is of particular concern since most houses have no forced ventilation air and new houses are being built tighter and tighter. Therefore, in the summer months there is a very low rate of outside air introduced and in essence you have a closed system with continuous introduction of formaldehyde and other contaminants from the HVAC ducts. This problem is exacerbated as the outside temperature increases above 105F and attic temperatures, where most HVAC equipment is located, exceeds 120F.

During the last three years we have tested several houses and are starting to develop a profile for houses that have high levels of formaldehyde and other organic vapors due to off-gassing of insulation materials inside HVAC air handling systems. This summer we were able to by word of mouth find people who were suffering health problems which we thought could be related to high levels on formaldehyde. In all but one case, we found that there was good correlation between the concentration of formaldehyde and the general health of the resident. I have attached one case study in which the individual had been to various medical doctors but none could find a cause for her burning eyes and congestion. By making some changes to the HVAC system, we were able to reduce the formaldehyde concentration to near the recommended CA-1350 level and within a day the health of the resident was improving and within a week she looked like a different person.

In 2005, we will start a local program to educate and inform people living in adult communities about the possible correlation between allergic-type health issues with high levels of formaldehyde emitted from their HVAC systems. This is the AWARENESS part. We will also offer them the opportunity for us to monitor the formaldehyde level in their home and recommend changes they can make to their HVAC system that will reduce the formaldehyde level to near the CA-1350 recommendation.

The problem with this approach is that many residents will not be able to afford the fee required to monitor the formaldehyde level or make the necessary changes to the HVAC system. Herein is where we need support from government agencies. I see no provision in your report to the California Legislature to consider this type of assistance. There is certainly a need to reduce source emissions by using cleaner building materials and controlling outside emissions. However, there is also a very clear need to identify the senior groups who are being impacted by poor indoor air quality and provide them the assistance they need to improve their quality of life. Since Arizona is not nearly as progressive as California to make improvement to indoor air quality, I am not optimistic about getting support from agencies in Arizona. However, as we start educating the seniors living in local communities the pressure to do something will mount.

If you have any questions I would be happy to discuss them with you.

Charles I Davis
President
Regal Air Quality, Inc.
Attachments: Case Study 004

HVAC System Off-Gassing at Elevated Temperatures in Residential Houses

Case Study 004
Trilogy C- House
Gilbert, AZ 85297

August 9, 2004

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Executive Summary

This case study concerns a resident who lives in the Trilogy community located in Gilbert, AZ. The resident has complained about irritated eyes, sore throat, and congestion since she turned on the air conditioning this spring. She has been to an Ophthalmologist and Allergist but they could find nothing that would cause her problems. Last week she communicated her problems to another Trilogy resident who has suffered similar problems. In this case, the problems were linked to prolonged exposure to high levels of formaldehyde. The formaldehyde and VOC levels were monitored in the resident's house, referred to in this report as the Trilogy C House. The initial results showed that the peak formaldehyde concentration was about 3.75 times the level recommended by the State of California's CA-1350 guideline (0.027ppm). Although there is no government regulation to set the acceptable formaldehyde concentration in residential houses, CA1350 is a new guideline being used for new California state buildings and it is believed this will eventually find its way to residential houses.

Fortunately, the homes in Trilogy have provision for bringing in outside air. This outside air adds to the cooling load but also gives the residents an option to reduce indoor air contaminants. The amount of outside air was increased by setting the HVAC fan to run 10 minutes every hour. It is estimated that the inflow of outside air was increased by 40%. The formaldehyde level was reduced to just over 2.5 times the CA-1350 guideline. This was significant reduction considering that on one of the test days the outside temperature reached 112F. It is well known from previous research that formaldehyde generated in the HVAC system is very dependent upon the attic temperature which obviously has a correlation to outside temperature. Details of this research can be found in a recent report we have written entitled HVAC System Off-Gassing at Elevated Temperatures in Residential Houses. One day the outside temperature was only 98 F and with increased outside air, the formaldehyde concentration had a maximum peak of 1.5 times the CA-1350 guideline and for much of the day was less than guideline.

Based on other work we have done, the formaldehyde concentration can be further reduced by, decreasing the thermostat set temperature from 79F, increasing outside air, or insulating the HVAC air distribution plenums. The most energy conserving approach is to insulate the air plenums. Using R-8 insulation will keep the HVAC air handling system below the critical formaldehyde off-gassing temperature and may allow the resident to go back to the standard outside air setting.

The resident of the Trilogy C House seems to be experiencing some relief since the formaldehyde concentration has been reduced. However, we have recommended that the air distribution plenums be insulated to further reduce the concentration of formaldehyde.

I. Introduction:

This case study concerns a resident who lives in the Trilogy community located in Gilbert, AZ. The resident has complained about irritated eyes, sore throat, and congestion since she turned on the air conditioning this spring. She has been to an Ophthalmologist and Allergist but they could find nothing that would cause her problems. Last week she communicated her problems to another Trilogy resident who has suffered similar problems during the summer. In this case, the problems were linked to prolonged exposure to high levels of formaldehyde. We agreed to set up instrumentation in her house and continuously monitor the formaldehyde and VOC levels. Although we monitored total VOC, this report will cover only the formaldehyde results.

II. Test Procedures:

The total VOC level was measured with a Spectrex Model SXC-20 VOC monitor and the formaldehyde concentration was measured with a Bionics TG-KAPII HCHO Detector. Both instruments were equipped with programmable data loggers. In addition, remote reading digital thermometers were placed in the attic and on the surface of the HVAC air distribution plenums.

III. Results for Standard Outside Air:

The first day of testing was done with the resident's house operating in the same way it has been all summer namely, thermostat set at 79F and outside air at the standard setting. The results showing formaldehyde concentration and attic temperature for the first test day, August 4, 2002, are shown in Figure 1. The maximum outside temperature was 107F and average Relative Humidity was about 15%. The reason we record RH is that the rate of formaldehyde formation from the fiber glass inside HVAC systems increases nonlinearly with increasing RH.

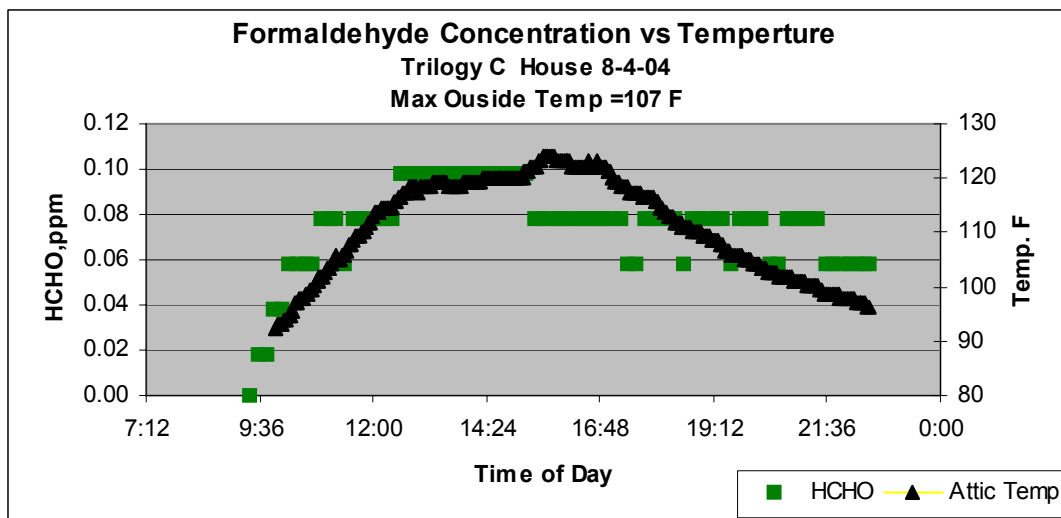


Figure 1. Formaldehyde Concentration Vs. Time of Day –Standard Outside Air.

The formaldehyde concentration increases as the attic temperature increases, reaching a peak of about 0.10 ppm at 13:00 and then decreasing with falling attic temperature. Is 0.1ppm a health risk? There is no government standard tot set the concentration of formaldehyde in residential houses. We also know that like other chemicals some people are more sensitive to formaldehyde than others. However one thing is clear formaldehyde is coming under greater scrutiny world wide as more clinical evidence shows it to be a high potential carcinogen and a strong irritant.

Recently the State of California has issued a guideline for formaldehyde and 50+ other organic vapors that must be met in all new government buildings. It is believed that this guideline will soon become a standard and will impact what is acceptable in residential houses. The CA-1350 level for formaldehyde is 0.027 ppm. There is significant research and clinical testing behind the CA-1350 guideline so this is what we will use as a reference for this report. It may be considered too conservative by some but we feel comfortable following the lead of the State of California.

The results for the second day of testing August 5, 2003 are for a 24 hr period since we wanted to monitor the rate of change in formaldehyde concentration through the day and night. These results are shown in Figure 2. The maximum outside temperature was 103F and the RH was 25%

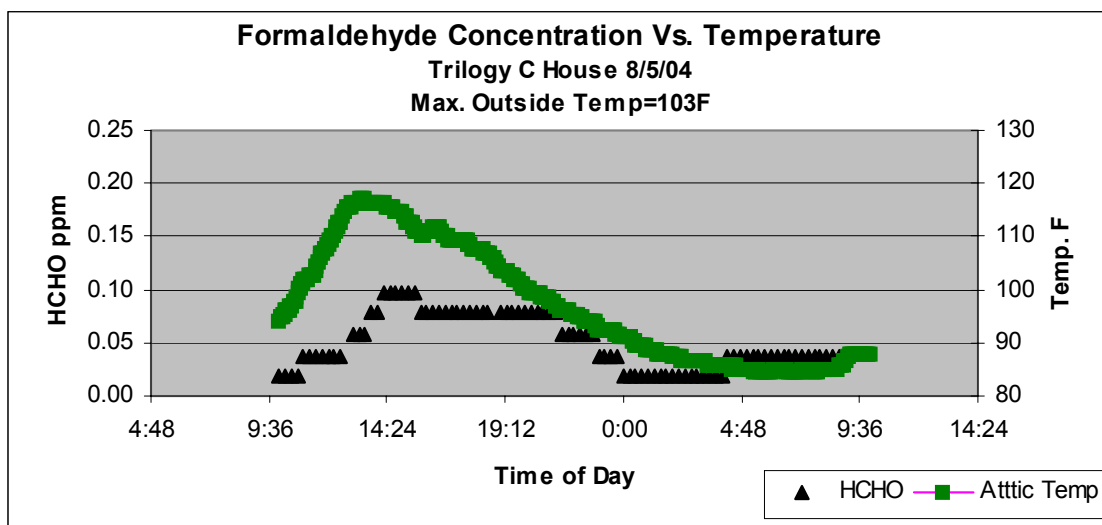


Figure 2. Formaldehyde Concentration Vs. Time of Day –Standard Outside Air.

IV. Results for Increased Outside Air:

Fortunately, the homes in Trilogy have provision for bringing in outside air. This outside air adds to the cooling load but also gives the residents an option to reduce indoor air contaminants. The amount of outside air was increased by setting the HVAC fan to run 10 minutes every hour. It is estimated that this increased the amount of outside air by 40%. The outside air flow rate was about 150 cfm.

The first day of testing with increased outside air, August 6, 2004, was a rather cool day with maximum outside temperature of 98F. The RH was very high averaging over 50%.. The results for this day are shown in Figure 3. The maximum formaldehyde concentration was less 0.04 ppm and for most of the day was below the CA-1350 guideline of 0.027 ppm. The attic temperature reached 110 F and the air plenum temperature was less than 100F most of the day. We know from previous work that if the HVAC system can be maintained below 100F and preferably below 90F the formaldehyde off-gassing will be minimal. The simplest and most economical way to protect the HVAC system from the hot attic is to insulate it with at least R-8 insulation.

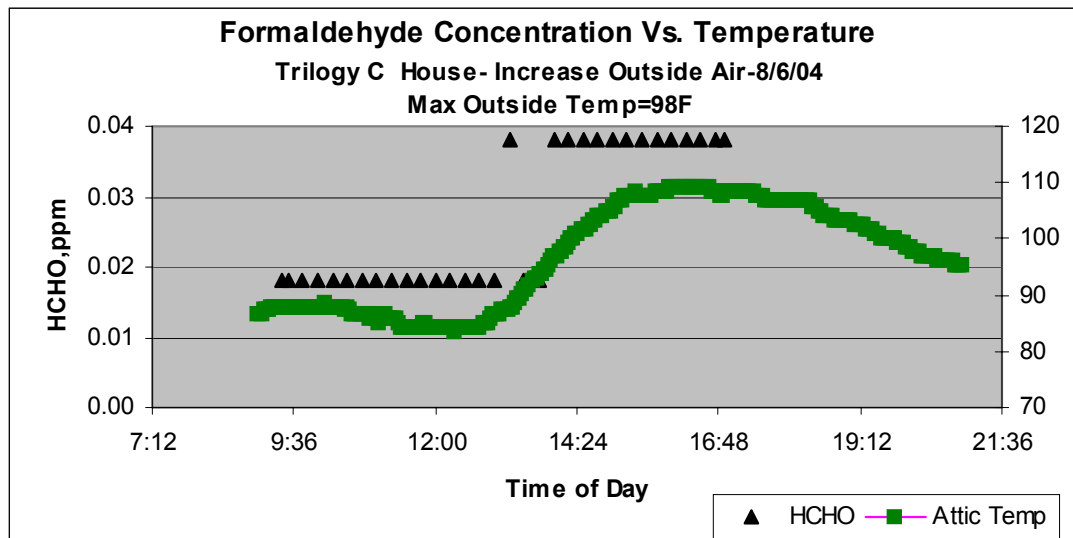


Figure 3. Formaldehyde Concentration Vs. Time of Day –Increased Outside Air.

The results for day 4 and day 5 August 7 & 8, 2004 are shown in Figures 4 & 5 respectively. On August 7 the outside temperature was 107F the same our first test day with standard outside air. The RH was about 17%. The affect of the increased outside air can be seen, as the peak formaldehyde concentration on August 7 was less than 0.08ppm. August 8 was even hotter with the outside temperature exceeding 112F. The RH was very low at 12%. The peak formaldehyde concentration was still less than 0.08ppm and for most of the day was less than 0.06ppm. Some indoor air quality experts would consider this to be a very acceptable level.

Since August 8 was much a much hotter day than August 7, we might expect the formaldehyde concentration to be higher. However, as we mentioned previously, formaldehyde off-gassing rate is very strongly coupled to the relative humidity and the RH was higher on August 7.

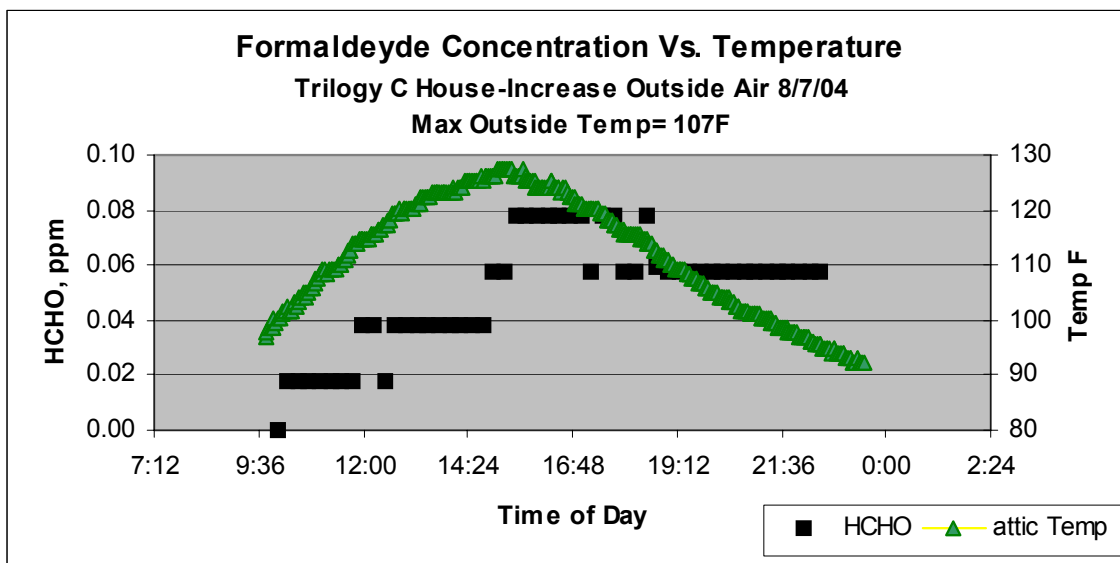


Figure 4. Formaldehyde Concentration Vs. Time of Day –Increased Outside Air.

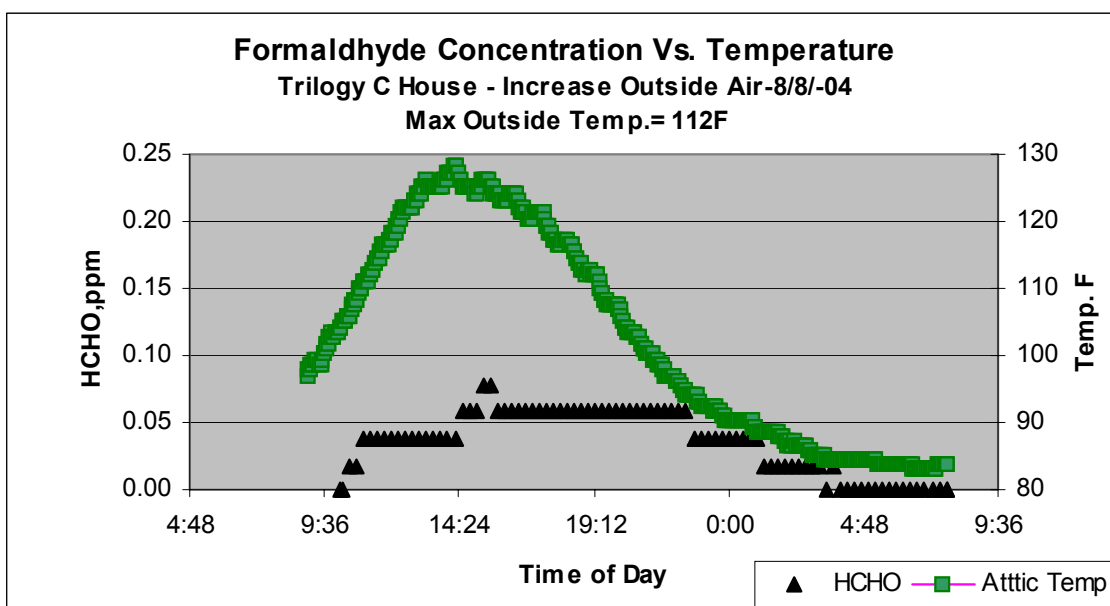


Figure 5. Formaldehyde Concentration Vs. Time of Day –Increased Outside Air.

V. Attic and Air Plenum Temperature Results:

Remote reading temperature probes were placed in the attic and on one of the air distribution plenums. The most important parameter is the plenum temperature. We know from previous research and other case studies that when the metal plenum exceeds 100°F, there is a very high probability that formaldehyde and other organics will be off-gassed into the conditioned air stream. Results comparing attic and air plenum temperatures are shown for each test day in Figure 7.

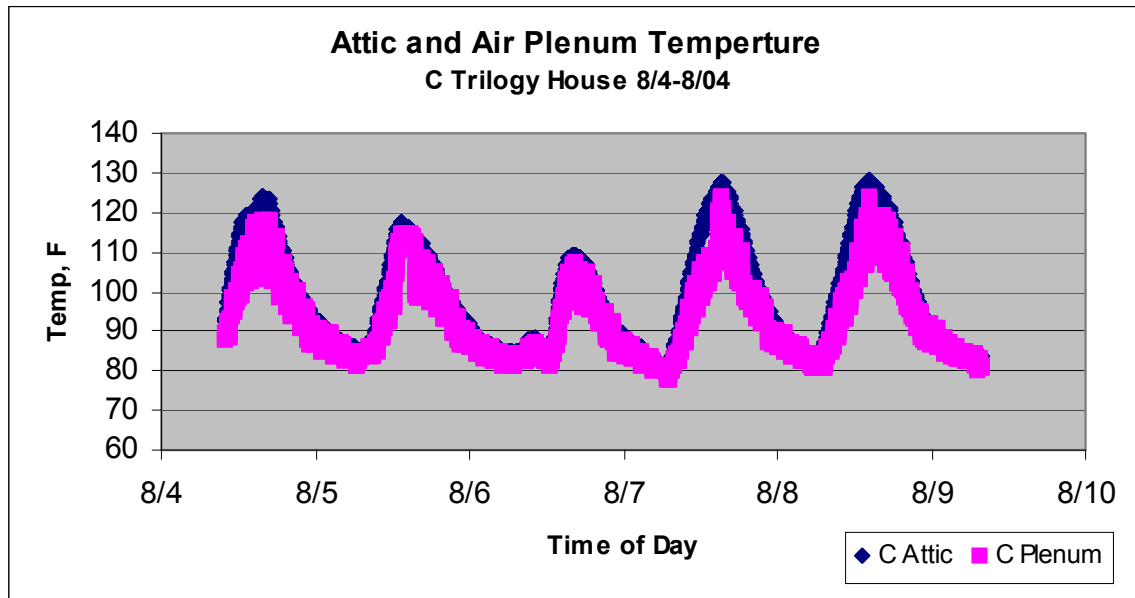


Figure 7. Attic and Air Plenum Temperatures for Test Days August 4-8, 2004

Figure 7 shows that the attic temperature and air plenum temperature to be about the same. There is a large portion of the time that the wall of the air plenum is over 100F. If we take a closer look at August 8 results, we can see the affect of the HVAC fan coming on. The results in Figure 8 show temperature cycles to be about one hour in frequency. This detailed temperature data clearly shows that insulating the air plenums to keep the walls below 100F will pay big dividends in terms of reducing the formaldehyde off-gassing and consequently reducing the amount of outside air that has to brought in.

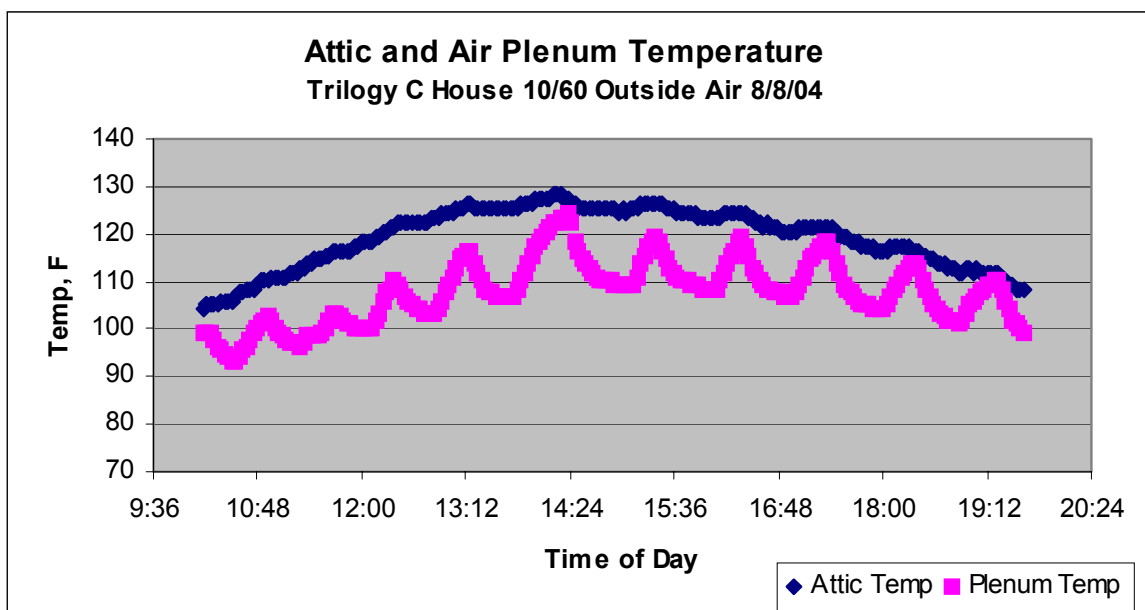


Figure 8. Close up of Attic and Air Plenum Temperature – 10/60 Outside Air.

VI: Summary:

The formaldehyde concentration in the Trilogy C House was found to reach a peak of 0.1ppm when the thermostat was set at 79F and standard outside air setting was used. This level is high enough to cause some of the health problems that the resident has been complaining about and reduction of formaldehyde by increasing outside air seems to be providing some relief. It is suggested that further reduction of formaldehyde can be achieved by insulating the HVAC air handling system. This should reduce the formaldehyde concentration to levels suggested by the California 1350 guideline and provide a very healthy house.